Chapter Three

Design Standards

Designers are called upon to make numerous decisions as to the geometrics and physical characteristics of highway improvements. Without some basic framework of design standards, the judgments of individual designers may vary considerably. The purpose of design standards is to assure that highway improvements are consistently designed with due consideration of appropriate levels of traffic service, safety, and economy, consistent with the environmental and social context of the area (context sensitive).

Selecting design standards that are context sensitive is an important part of the design process. Chapter Ten, Section 10.1, Context Sensitive Design, describes this concept. The designer is reminded that there is flexibility in the standards set forth by AASHTO and this manual that allows choices to be made as the design progresses and complex community and environmental issues are raised. Since there are so many decisions made during the design process affecting design standards, documentation of these decisions is a critical part of the design process. This is particularly important on projects with extensive community involvement and an extended design process where previously discussed and resolved issues continue to be raised. Other reference publications on context sensitive designs are AASHTO's *Context Sensitive Design for Integrating Highway and Street Projects with Community and the Environment*, and FHWA's *Flexibility in Design.*

3.1 BASIS FOR STANDARDS

The concept of design standards has evolved from extensive highway agency field-testing, research, mathematical modeling and the study and documentation of many years of application and experience. The findings and conclusions are documented in many publications that serve as guides for highway designers. The design standards are flexible in that agencies must adopt those that are proven to work best for area(s) over which they have jurisdiction. Elements that influence selecting design standards include topography, geographical location, physical geology, predominant weather conditions, population growth, traffic volumes, predominant types of vehicles, past operational experiences, state and local transportation goals, community interests and other conditions that may affect the area of agency responsibility.

The flexibility to select project specific design standards does not compromise the national goal of maintaining a standard design. The concept of a standard design is reached through the consistent application of design principles. Drivers can reasonably expect transportation agencies to apply the same design principle when encountering similar conditions throughout the United States allowing the driver to be prepared and react in a consistent manner. For instance, all freeway ramps will have deceleration lanes and consistent signing.

3.1.1 AASHTO POLICIES AND GUIDES

The American Association of State Highway and Transportation Officials (AASHTO) is the recognized authority on American highway design policies and standards. Since 1938, AASHTO has been developing and publishing design policies and guides for use by transportation agencies and continues to update the information to reflect new findings and the current state of knowledge.

This manual cannot attempt to cover the total scope of important published information related to highway design policies.

3.1.2 APPLICATION OF STANDARDS

Depending upon the design element being evaluated, AASHTO design criteria are expressed as design values, minimum values or as ranges of values for particular elements and conditions. Design values are empirically derived; any value lower may be unsafe and any value higher may be unnecessary and uneconomical. Minimum values should, depending upon the element being evaluated, not be lowered either because it will create an unsafe condition or, in some cases, will not physically work. Some design elements lend themselves to minimum and desirable values. Although a portion of a project may require the application of minimum values, other sections will allow the designer to use standards higher than the minimum. In evaluating a project for application of standards, user expectation is important. Consistency in application of standards is an important safety feature. Large variances in standards may create unacceptable driver behavior. AASHTO standards are developed to allow agencies to select those that best meet their needs and practices.

Design values presented in this manual are in metric and US Customary units and were developed independently within each system. The relationship between the metric and US Customary values is neither an exact (soft) conversion nor a completely rationalized (hard) conversion. The metric values are those that would have been used had the manual been presented exclusively in metric units; US Customary values are those that would had been used if this manual has been presented exclusively in US Customary units. Therefore, the user is advised to work completely in one system and not attempt to convert directly between the two. Figure 3-1 shows the equivalent US Customary and Metric units for the commonly used design speeds.

Figure 3-1
Corresponding Design Speeds in
US Customary and Metric Units

US Customary	**Metric**
Design speed (mph)	**Corresponding Design speed [km/h]**
15	20
20	30
25	40
30	50
40	60
45	70
50	80
55	90
60	100
70	110

The standards adopted by the Delaware DOT, described herein, adhere to the basic framework of AASHTO design policies. But the specific standards contained herein reflect judgments by the Department as to their proven operational success in Delaware and application to the predominant geographical conditions.

Most standards are related to a facility's functional classification with the interstate system having the highest and local streets having the lowest. For instance, 10 ft [3 m] travel lanes may be acceptable on local streets but completely unacceptable on facilities with high volumes, higher operating speeds, a more diverse mix of vehicle types, and a goal of maintaining or improving system capacity.

3.1.3 DEPARTURE FROM STANDARDS

Most projects are expected to meet at least the minimum standard design values established for the project level. Occasionally there may be conditions that warrant consideration of a lower value. For projects on higher functional classification roadways, it is more critical to strive to meet or exceed all of the applicable standards, primarily because the motorist expects a higher standard and will drive the facility accordingly.

The design standard to be evaluated for an exception should be a major design element that will control the design. Major controlling design elements include:

- Design speed;
- Through lane and auxiliary lane widths;
- Shoulder widths;
- Stopping sight distance on vertical and horizontal curves;
- Horizontal alignment (radius of curve);
- Vertical alignment;
- Minimum and maximum grades;
- Cross slopes;
- Superelevation rate;
- Horizontal clearance;
- Vertical clearance;
- Bridge width; and
- Structural capacity.

The project scope, funding, functional classification and other factors influence the selection of appropriate design standards. Variances from these standards need some level of documentation for project files. New construction and reconstruction projects require greater detail on the rationale for departure from the established design standards and must be thoroughly documented.

New construction, reconstruction, and projects on the interstate and the NHS are expected to be in conformance with the appropriate standards and exceptions should be rare. For all projects on the NHS, except preventive maintenance, the standards are those in the current edition of the AASHTO publication *A Policy on Geometric Design of Highways and Streets.* For all projects, except preventive maintenance, on the interstate system, the design criteria to be met are contained in the current edition of *A Policy on Design Standards—Interstate System.*

Design exceptions for projects on the NHS and interstate having FHWA oversight as established in the current *Delaware Transportation/Federal Highway Administration Stewardship Agreement to Implement the Flexibility of Provisions of 23 United States Code Part 106* must have FHWA approval. The Chief Engineer approves design exceptions for state administered projects. Figure 3-2 is a guide format for developing a design exception request.

An exception for design speed should not be sought as this element establishes most if not all of the other parameters to be met. As discussed in this chapter and in several other sections in this manual, design speed is an achievable speed selected by the designer based on the various factors the designer must consider. Design elements that can not be met within that selected design speed should be supported by seeking a design exception.

The need for exceptions to the standards must be identified early in the project development phase in order that approvals or denials will not delay completion of the design or require extensive redesign. However, the need to evaluate a lower design value may arise at any time during the design process and needs to be addressed expeditiously. Thorough documentation is essential. The need for exceptions should not be viewed as normal or routine. Use the forms in this chapter to document decisions on design criteria and as a basis for developing and documenting requests for exceptions. The designer must provide the supporting rationale. The primary focus of the request should be highway safety. The designer's proposal should be the best practical alternative that considers whether or not other controlling design elements will be adversely affected.

Depending upon the significance of the request, the support information may include some or all of the following:

- Existing roadway characteristics,
- Required and proposed design criteria;
- Cross section or geometric figures comparing the existing and proposed conditions;
- Supporting calculations and cost analysis;
- Analysis of accident records;

- A discussion on the compatibility with adjacent sections;
- Mitigation costs;
- Effect on right-of-way;
- Environmental constraints;
- Public support or opposition; and
- Other pertinent factors.

3.1.4 DETERMINATION OF STANDARDS

Figure 3-3 graphically defines the nomenclature used when describing the various elements that establish a roadway's cross section. The dimensions and geometrics needed to design this roadway section are known as a project's design standards. The basic information needed before beginning the process of establishing a project's design standards is:

- The ***functional classification*** of the road section to be improved. A roadway's classification is shown on DelDOT's current functional classification map but should be verified with the Division of Planning. A part of the initial field review and scoping meeting should be to verify that the area and roadway section being considered are truly representative of the designated classification.

- The ***scope of work*** proposed for the project under consideration is in the Project Initiation Form, project development documentation and other supporting data furnished to the designer.

- The ***traffic data*** for the road section is obtained from the Division of Planning and includes current traffic, projected traffic, percent trucks, accident history, etc.

With this information, the designer can proceed with the process of selecting the design speed.

3.2 STANDARDS BASED ON DESIGN SPEED

3.2.1 SELECTION OF DESIGN SPEED

The design speed establishes basic criteria for certain design elements. Two design standard considerations are related directly to the design speed:

- Curvature and superelevation, and
- Required sight distances.

The designer's goal is to provide at least the minimum values, and preferably larger values, for these standards, regardless of traffic volumes, functional classification or any other consideration. These design elements are very closely related to traffic safety and should not be compromised.

A first step in determining the appropriate design standards is to establish a reasonable and realistic design speed. Since the majority of design controls are related to the design speed, this decision needs to be based on more factors than a roadway's functional classification and traffic volume.

The design speed selected should accommodate a high percentage of drivers, including the reasonable and prudent driver. Other considerations include topography, anticipated operating speeds, driver expectations, volume and mix of vehicles, the volume and type of non-vehicular traffic, driver familiarity, level of congestion reasonably acceptable to the motorists, and community values.

Figure 3-2
Design Exception Request

State Project No._________________Federal-Aid Project No.__________________________

Date: __________________________**Oversight Project: Yes ______No____**

Design Exception Abstract: (Provide a short summary detailing the nature of the exception, reasons for the request, etc.)

Note:
For all NHS projects, the thirteen controlling criteria to be met are design speed; through lane and auxiliary lane width; shoulder width; bridge width, structural capacity, horizontal alignment; vertical alignment; grades; stopping sight distance, cross-slope; superelevation; horizontal clearance; and vertical clearance.

RECOMMENDATION:

The purpose of this project is to----------.

The most effective method of addressing this is-----------.

Based upon the conditions presented, it is recommended that a design exception be approved for the controlling substandard design element as justified.

Recommended By: ____
Squad Manager

Recommended By: ____
Group Engineer

Recommended By: ____
Assistant Director-Transportation Solutions

Recommended By: ____
Assistant Director-Design

Approved By: ______________________________ **Date**: ___________________
Chief Engineer

Approved By: ______________________________ **Date**: ___________________
Federal Highway Administration (NHS oversight projects only)

Enclosures: (Include design criteria, figures, calculations, etc. to document request.)

Once the design speed is selected, the pertinent highway features need to be related to obtain a balanced design. Some design features, such as curvature, superelevation, and sight distance, are directly related to, and vary with, design speed. Other features, such as lane and shoulder widths and clearances to highway appurtenances, although not directly related to design speed, affect the driver's comfort level and are reflected in vehicle operating speeds.

Designers should evaluate any unique conditions that might indicate a practical need for a higher or lower design speed. For example:

1. Design speeds should be selected as high as economically and physically practical.
2. The highway section may be legally posted for a relatively low operating speed; selecting a higher design speed may result in considerable added cost. Therefore, it would be appropriate to accept a lower design speed which is 5 mph [10 km/h] above the posted speed.
3. Extensive roadside development and proposed land-use changes, intersection spacing and frequency of entrances may influence decisions on design speed.
4. The need to preserve historic sites and districts may be a controlling factor.
5. The impact on the social context of the affected project area should be evaluated. This is particularly important when a project involves a rural setting and extends into a town center type of environment.
6. The impact on environmentally sensitive areas are part of the decision making process.
7. Whether or not the 85th percentile speed criteria should be used will have to be evaluated.

Keep in mind, however, that lowering the design speed will not necessarily lower operating speed without also lowering the legal posted speed limits. Before a final decision is made on the design speed, the adjacent road sections should be evaluated in terms of current operating speed characteristics and the potential for future reconstruction work. To the extent practicable, it is desirable to have consistent design speeds over longer sections of highways, where the roadway and roadside characteristics are also consistent and similar. If the adjacent roadside characteristics, traffic mix, and user activities vary dramatically within a project's limits, it may be more reasonable to use several design speeds This would be applicable when entering a business district or other activity center involving increased pedestrian use and cross traffic.

Since design speed selection is one of the most significant decisions, it is important to document the basis for making the selection and obtain approval before proceeding with the design. As the design process proceeds there may be issues raised that will call for a reevaluation of the design speed decision.

In addition to the design speed, a facility's projected traffic volume and functional classification influence the selection of traveled way (lane) and shoulder widths. The designer should refer to the Green Book in establishing traveled way and shoulder widths. The following is a guide to help locate this information.

- Local Roads and Streets — page 388, Exhibit 5-5;
- Collector Roads and Streets (Rural) — page 429, Exhibit 6-5;
- Collector Roads and Streets (Urban) — page 437;
- Arterials (Rural) — page 452, Exhibit 7-3;
- Divided Arterials (Rural) — page 459;
- Urban Arterials — page 476;
- Freeways — page 508.

Determining lane and shoulder widths is a very critical step in project design. The Design Criteria Form, Figure 3-5, is used to document and obtain approval for the selected lane and shoulder widths.

3.2.2 CURVATURE AND SUPERELEVATION

Establishing the proper relationship between design speed and curvature, as well as their joint relationship with the proper amount of superelevation on the curve is an important decision. Although these relationships are derived from laws of mechanics (speed, centrifugal force and side friction factor), the actual values for use in design depend on practical limits and factors determined empirically over a range of variables. For example, the maximum permissible rate of superelevation is based on a practical consideration that a high operating speed can be accommodated on a relatively sharp curve if the superelevation is steep enough, but highways must serve vehicles traveling at a wide range of speeds. Slow moving vehicles or stopped vehicles would be adversely affected with excessively steep superelevation, particularly in ice and snow conditions.

AASHTO suggests maximum superelevation rates in the range of 4 to 12 percent. Delaware's roadways are subject to the effects of ice and snow during the winter. These conditions have resulted in poor operational and accident history on roadways using a superelevation rate higher than 8 percent. Therefore, DelDOT strives to use a maximum superelevation rate of 6 percent. However, for rural roadways it may be appropriate to use a superelevation rate of 8 percent. In urban areas, it is more practical to use a rate of 4 percent. This rate allows for smoother pavement tie-in at entrances and intersecting streets.

The selected superelevation rate sets the limitations on curvature. It is desirable to use curves flatter than the minimum values wherever conditions permit. When approved by the Chief Engineer, curves sharper than the minimum may be used on reconstruction projects. The designer has design alternatives to mitigate the effect of introducing sharper curvature by widening pavement, providing advance warning signs, providing wider clear zones, increasing vertical or horizontal sight distances, etc.

Tables of superelevation rates for various combinations of design speed and curvature are shown in the Green Book, pages 156 to 161, and figures in Chapter Five - Alignment and Superelevation in this manual. Both of these should be referred to for a more detailed discussion of the application of superelevation and transition methods for entering and leaving horizontal curves.

3.2.3 STOPPING SIGHT DISTANCE

Sight distance is the length of roadway ahead of the vehicle that is visible to the driver. The available sight distance must always be sufficient to enable a vehicle traveling at or near the design speed to stop before reaching an object on the roadway. Factors that influence the required stopping sight distance include:

- The speed of the vehicle;
- The height of the driver's eyes;
- The height of the object on the road;
- The driver's reaction time before braking;
- The surface condition; and
- The distance necessary to stop the vehicle after applying the brakes.

Reference should be made to Chapter 3 Elements of Design in the Green Book, pages 109-117, for a thorough explanation of the concepts and procedures for defining stopping sight distances. Attention is also drawn to AASHTO's discussion of the concept of 'decision sight distance' and its possible application to the project under design.

Vertical curvature, horizontal curvature, roadside obstructions, or any combination of these elements can restrict sight distance. Procedures for checking available sight distances are described in the Green Book, pages 127-131.

3.2.4 PASSING SIGHT DISTANCE

Consideration of passing sight distance is limited to two-lane, two-way highways on which vehicles frequently overtake slower-moving vehicles and the passing operation must be accomplished on a lane used by opposing traffic.

Passing sight distance for design is determined on the basis of the length needed to accomplish the passing maneuver. Derivation of the required distance is described in the Green Book, pages 118-126. AASHTO recommends that, "In designing highways these distances should be exceeded as much as practical ..."

These distances for design should not be confused with other distances used as warrants for placing no-passing pavement markings on completed highways. Values shown in the MUTCD are substantially less than the design distances and are derived from traffic operation control needs based on assumptions different from those for design.

Because of vertical and horizontal sight limitations, nearly all two-lane highways have some no-passing restrictions. In rolling terrain, the proportionate amount of no-passing sections usually becomes greater. Normally it is impracticable to attempt to provide passing sight distance throughout the entire length of a project. The principal design consideration is to try to provide adequate passing opportunities as frequently as possible.

There are no fixed values for the frequency of passing sections. Experience shows that highway capacity is measurably reduced when a significant percentage of a section of highway is restricted to sight distances less than 1500 ft [500 m]. Highways with high traffic volumes will require a higher proportion of passing opportunities than those with low traffic volumes. Where an analysis shows that a lack of passing sight distances has reduced capacity to near or below the expected traffic volumes, it is necessary to consider adjustments in the alignment and grade, or to provide additional lanes.

3.3 STANDARDS BASED ON TRAFFIC VOLUMES

Standards not directly related to design speed are influenced primarily by traffic volumes. Tables for these standards shown in the tables at the end of this chapter reflect variations by traffic volume ranges.

3.3.1 NUMBER OF LANES

The number of lanes required for any highway is directly related to the facility's traffic volume and desired level of service. But there are no simple, fixed criteria for these relationships. The recommended number of lanes is normally obtained through the project development process.

The *Highway Capacity Manual* gives two very general guidelines for determining the need for additional lanes. These numbers are based on long sections of roadway with uninterrupted traffic flow having the highest standards for design controls (horizontal and vertical geometrics and cross-sectional elements), ideal weather conditions, daylight, etc.

1. Under ideal conditions, a two-lane rural highway can accommodate about 900 passenger vehicles (two-way) per hour with a reasonably high level of service if there are adequate passing opportunities and no long, steep grades. Considerably more vehicles can be accommodated if motorists are willing to accept a lower level of service, a greater degree of congestion and lower operating speeds.

2. Under ideal conditions, a multi-lane highway can accommodate about 900 passenger vehicles per lane per hour. Again, considerably more vehicles can be accommodated, if lower levels of service can be tolerated.

Most roadways do not meet the ideal conditions. The HCM defines the ideal roadway as follows: (1) meets or exceeds design speed; (2) has 12 ft [3.6 m] travel lane widths; (3) has shoulder widths greater than 6 ft [1.8 m]; (4) has minimal no passing zones; (5) carries predominantly passenger cars; (6) has evenly distributed traffic flow; (7) has minimum crossing and entering traffic interference; and (8) has level terrain.

Although all these elements are rarely available within a project's limit, capacity is usually not a problem on most of the rural roadways in Delaware. Exceptions are some of the principal arterial routes, particularly in the vicinity of urban areas.

Most proposed improvements will be in traffic volume ranges where the existing number of lanes will be adequate without the need for detailed study. However, capacity may be influenced where the traffic volume exceeds about 900 DHV or where there are unusual conditions of alignment, grade or signalization.

Designers working with Traffic and the Division of Planning should identify the need for additional through lanes or, if applicable, auxiliary climbing lanes. Such a change after project initiation is a major decision affecting all aspects of a project from cost to environmental and social impacts.

3.3.2 SURFACED LANE WIDTHS

The traveled way designated for vehicle operation (excluding shoulders) normally consists of two or more surfaced traffic lanes. The impact of providing adequate lane widths is wide ranging and includes maintaining and/or enhancing driver safety, driver comfort, the level of service, capacity, and the frequency and extent of shoulder and pavement surface maintenance.

For all new construction and reconstruction on arterial and collector roads, the desirable surfaced travel lane width is 12 ft [3.6 m]. If the scope of work is limited, speeds are low, truck volumes are light or there are no defined safety problems, surfaced lane widths of 11 ft [3.3 m] may be acceptable, particularly in urbanized areas with restricted right-of-way and increased pedestrian activity. However, for urban arterials with higher speeds, predominantly free-flowing conditions, and higher traffic volumes, surfaced lane widths of 12 ft [3.6 m] are desirable. For local roads and streets, surfaced traffic lanes normally should be 11 feet [3.3 m] wide but AASHTO allows lane widths of 9 [2.7 m] or 10 ft [3.0 m] where there is restricted or low truck use, low traffic volumes and low operating speeds. See Section 3.2.1 for information on selecting lane and shoulder widths.

For pavements on new construction or major reconstruction projects with existing or projected high concentrations of truck traffic, a wider pavement provides more edge strength and has been found to be structurally better for heavy loads. Consideration should be given to widening the pavement an additional 2 ft [0.6 m] under these circumstances. The lanes should be striped for 12 ft [3.6 m] lanes to keep trucks away from the edge of the pavement. The extra width can be considered part of the shoulder. If the mainline and shoulders are constructed of Portland cement concrete and the shoulders are structurally tied to the mainline, this additional width is not normally necessary. For divided highways, the widening should be adjacent to the outside shoulder; on two-lane roadways the widening should be equally divided on each side.

3.3.3 SHOULDER WIDTH

The total shoulder width is the distance from the edge of the traffic lane to the intersection of the shoulder slope with the front slope, or to the face of curb. In sections without curbs there are two terms used to describe the shoulder area. The "graded" width of shoulder is that measured from the edge of the traveled way to the intersection of the shoulder slope and the front slope. The "useable" width of shoulder is the actual width that can be used when a driver makes a stop.

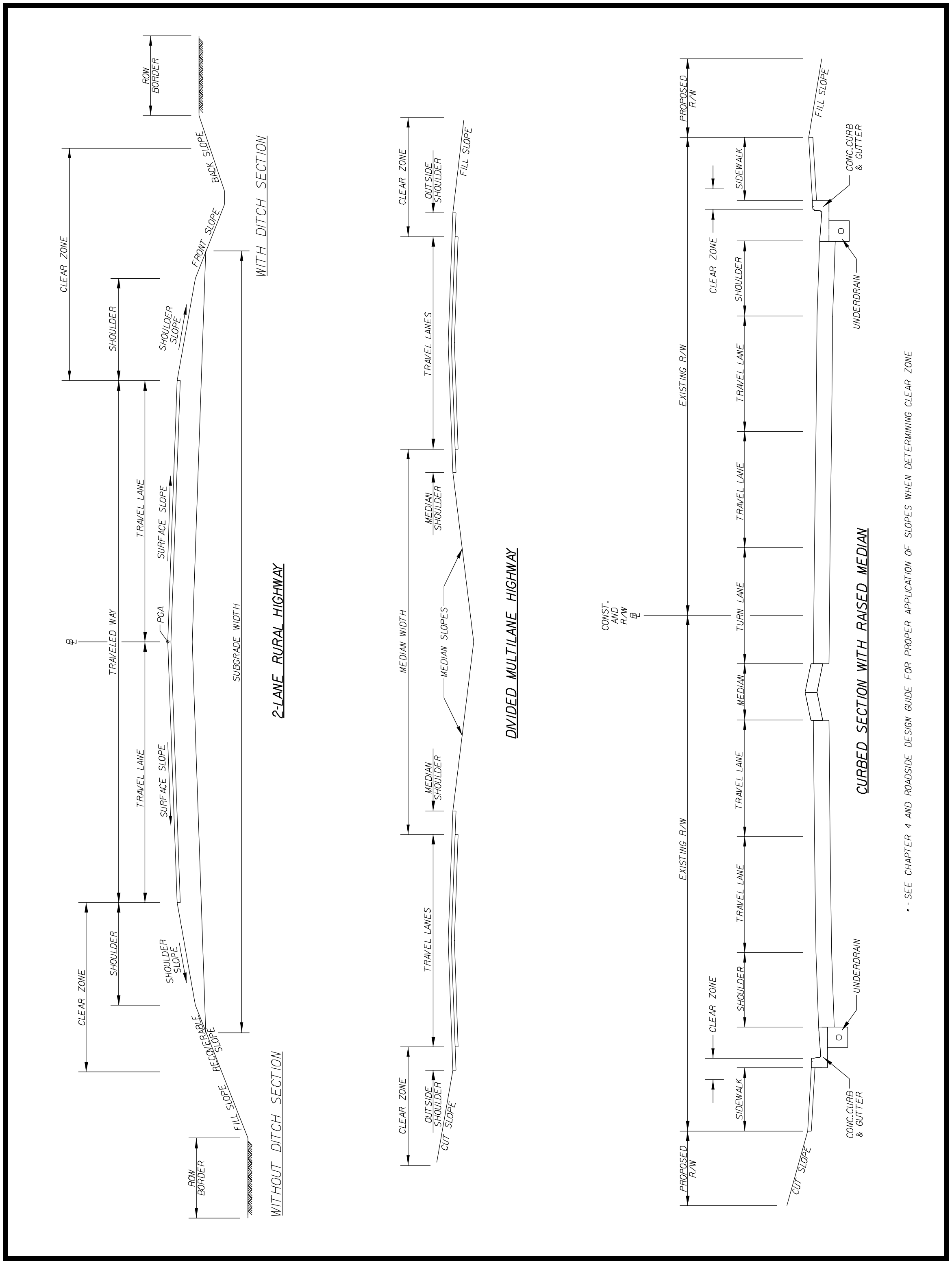
Having a sharp break at the point of intersection of the edge of the graded shoulder and the front slope is not a good practice. Instead a rounding of 4 to 6 ft [1.2 to1.8 m] with a front slope 4:1 or flatter is the best practice. This rounding improves the general safety of the roadside by reducing the likelihood of encroachment, thus giving the errant driver more chance to regain control. Other considerations are that rounding may reduce rollovers and the possibility that the vehicle may become airborne. A portion of the rounding (usually one half) can be considered part of the "useable" width. Where front slopes are steeper than 4:1, the rounding should occur outside of the useable shoulder width.

Well-designed and maintained shoulders are necessary on rural highways with any appreciable traffic volumes. Shoulders and their widths are an important consideration in establishing a project's design standards. The benefits of including a shoulder include:

- Providing a refuge when a driver makes an emergency or parking stop.
- Providing lateral recovery areas for vehicles that inadvertently leave the traffic lane.
- Providing improved sight distance in cut areas.
- Providing areas for maintenance operations, including snow removal and storage.
- Providing for alternative modes of travel by pedestrians, bicyclist, joggers, transit operations, etc.
- Structurally improving the service life of the pavement by increasing the stability of the roadway's base and surfacing materials at the edge of the through traffic lane.
- Providing the opportunity for improved subgrade drainage designs.

Section 3.2.1 discusses the selection of shoulder widths. Normally shoulder widths of 10 ft [3.0 m] are used on new construction projects for arterial highways with relatively high traffic volumes. Where truck traffic exceeds 250 DHV it is desirable to have a paved shoulder width of 12 ft [3.6 m]. AASHTO allows narrower shoulder widths on most roadways with lower traffic volumes. However, wider shoulders widths should be provided on these projects when practical. Where bicyclists and pedestrians are to be accommodated on the shoulders, a minimum useable shoulder width, clear of any rumble strips, of 4 ft [1.2 m] should be used. On highways with three or more lanes in each direction a median shoulder width of 10 ft [3.0 m] is desirable. This provides a refuge area for disabled vehicles without affecting roadway capacity and flow.

Figure 3-3
Typical Section Nomenclature



3.3.4 SURFACED SHOULDER WIDTH

The surfaced shoulder width is that part constructed to provide better all-weather load support than is afforded by natural soils or stabilized materials. The paved portion of the shoulder also protects the edge of the traffic lane pavement from deterioration and raveling. More discussion on shoulder surfacing is in Chapter Nine - Pavement Selection. Normally the shoulder's structural design, including surface material, is recommended by the Materials and Research Section.

3.3.5 SIDE SLOPES

Various cross section slopes are identified in Figure 3-3. Four of these slopes are described below.

- **Front Slope.** The slope extending outward and downward from the shoulder to the ditch line.
- **Back Slope**. The slope extending upward and outward from the ditch line to intersect the natural ground.
- **Fill Slope**. The slope extending outward and downward from the shoulder to intersect with the natural ground; it may include a ditch section.
- **Cut Slope**. The slope extending outward and upward from the shoulder, intersecting the ditch slope and then extending upward from the ditch back slope to natural ground.

It is generally desirable that these slopes be 6:1 or flatter. Often, from a practical standpoint, they must be steeper. There is a distinct relationship between the steepness of side slopes, operating speeds and the desirable widths of clear zones. Chapter Four discusses the relationship of these slopes to establishing a roadway's clear zone. General criteria for side slopes are presented in Figure 4-4, in terms of both desirable slopes and maximum slopes. The desirable slopes should be provided wherever feasible.

3.3.6 HORIZONTAL CLEARANCE AND CLEAR ZONE

3.3.6.1 HORIZONTAL CLEARANCE

Horizontal clearance is the lateral distance from edge of traveled way to a roadside feature or object for a roadway with barrier curb. Roadways having curbed sections should be provided with a minimum horizontal clearance of 1.5 ft [0.5 m] beyond the face of curb, with wider offsets (if possible to the full clear zone width) provided where practical since most types of curbs provide little help in redirecting an errant vehicle. Please see the Green Book for more information regarding horizontal clearance and AASHTO's Roadside Design Guide for more information regarding the clear zone width. If the minimum horizontal clearance cannot be provided in curbed areas, then a design exception is required.

3.3.6.2 CLEAR ZONE

The clear zone is defined in AASHTO's Roadside Design Guide as "the total roadside border area, starting at the edge of the traveled way, available for safe use by errant vehicles. This area may consist of a shoulder, a recoverable slope, a non-recoverable slope, and/or a clear run-out area. The desired width is dependent upon the traffic volumes and speeds and on the roadside geometry." This border area includes any shoulders or auxiliary lanes. Adequate lateral clearance between the edges of traffic lanes and roadside obstructions has been shown to be a very important safety factor. Vehicles leaving the roadway should have a reasonable opportunity to recover control and return to the roadway without overturning or colliding with roadside obstacles such as trees, poles, headwalls or other large objects. The combination of a relatively flat slope and an obstacle-free roadside within the prescribed clear zone helps this situation.

The determination of a clear zone is a function of speed, volume, curvature and embankment slope. The most current edition of AASHTO's *Roadside Design Guide* should be used for determining clear zone widths. For low-speed rural collectors and rural local roads, a minimum clear zone width of 10 ft [3.0 m] should be provided.

Some roadside appurtenances, such as guardrail, breakaway light poles and signs using breakaway posts, are permitted within the specified clear zone, due to their crashworthiness. They should be placed in the safest available location, minimizing their use when possible. Please refer to the *Roadside Design Guide* for more information. For guardrails within the clear zone, it is desirable to maintain a minimum 2 ft [0.6 m] lateral clearance between the outer edge of the usable shoulder and the face of the rail. At bridge approaches, guardrail should either match the width of the bridge or taper to meet the bridge rail.

The width of clear zone is included on the Design Control Checklist (Figure 3-4), the Design Criteria Form (Figure 3-5) and the title sheet of construction plans. Deviations from the clear zone criteria will have to be approved by the appropriate assistant director.

3.3.7 GRADES

Design standards for maximum grades are not as precise and objective as the standards for other geometric elements. AASHTO has established recommended maximum grades based principally on analyses of vehicle operating characteristics. Criteria for maximum grades are related principally to design speed, traffic volumes and terrain characteristics.

When it is necessary to design grades at or near the maximum values for relatively long distances, designers should investigate the effect on lane capacity. The lane capacity problem may be further complicated where there are steep grades accompanied by considerable no-passing distances.

More detailed guidelines and criteria for the design of grades, including critical lengths of grades and minimum and maximum grades are presented in Chapter Five - Alignment and Superelevation and the Green Book, pages 235-254. The maximum grades should be used infrequently, only as dictated by severe terrain conditions. When it is necessary to use maximum grades, the designer should check other design criteria and roadside features that may be improved to minimize the impact of using the higher design grade.

3.3.8 BRIDGES

The designer should coordinate with the Bridge Design Section when determining vertical clearances. A minimum vertical clearance for roads over interstate, U.S. and state routes is 16.5 ft [5 m]. Pedestrian bridges and overhead sign structures must have an extra 1 foot [0.3 m] of clearance, a total of 17.5 ft [5.3 m]. These clearances allow for a 4 in. [100 mm] future resurfacing.

3.3.9 MEDIANS

Geometric criteria for medians on multilane divided highways are discussed in Chapter Four.

Figure 3-4
Design Control Checklist

PROJECT DATA

Squad Leader/Project Manager: ____

Project Title: ____

Contract No.: ____

Federal Aid Project No: ____

Project Limits: ____

Type of Construction: ____

Project Scope and Initial Estimate: ____

____

____

____

DESIGN DATA

Functional Classification: ______________

Current AADT (Year) ______________

Projected AADT (Year): ______________

Projected DHV (Year): ______________

% Trucks ______________

Directional Distribution (%): ______________

Design Speed ______________

Design Vehicle ______________

Design Level of Service ______________

Clear Zone ______________

Recommended By: ____
Squad Manager

Recommended By: ____
Group Engineer

Recommended By: ____
Assistant Director-Transportation Solutions

Approved By: ____
Director-Transportation Solutions

Figure 3-5
Design Criteria Form

Design Criteria		
Design Factor	**As per Road Design Manual**	**Provided**
Design Speed*		
Width of Through Lanes*		
Width of Auxiliary Lanes*		
Width of Outside Shoulder*		
Width of Inside Shoulder*		
Cross Slope*		
Width of Median		
Stopping Sight Distance*		
Minimum Horizontal Curve Radius*		
Minimum K (Crest)*		
Minimum K (Sag)*		
Maximum % Grade*		
Maximum front slope (Unprotected Section)		
Maximum back slope		
Barrier Offset		
Superelevation Rate (%)*		
Bridge Width*		
Vertical Clearance*		
Structural Capacity*		
Horizontal Clearance *		
Width of clear zone		

General Notes:
- Use this form primarily for new construction or reconstruction projects.

* The Chief Engineer must approve design criteria deviating from the requirements of the Road Design Manual through the use Figure 3-2 “Design Exception Request.”

Recommended By: ______________________________
Project Manager

Recommended By: ______________________________
Group Engineer

Approved By: ______________________________
Assistant Director-Transportation Solutions